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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/720,839	11/24/2003	Robert J. Steger	LMRX-P028/P1187	3615

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EXAMINER	
PRUCHNIC, STANLEY J	
ART UNIT	**PAPER NUMBER**
2859	

DATE MAILED: 05/20/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Office Action Summary	Application No.	Applicant(s)	
	10/720,839	STEGER, ROBERT J.	
	Examiner	Art Unit	
	Stanley J. Pruchnic, Jr.	2859	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 15 April 2005.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-49 is/are pending in the application.

4a) Of the above claim(s) ______ is/are withdrawn from consideration.

5)☒ Claim(s) 49 is/are allowed.

6)☒ Claim(s) 1-48 is/are rejected.

7)☐ Claim(s) ______ is/are objected to.

8)☐ Claim(s) ______ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 24 November 2004 is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. ______.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date 2/14/05. (2 sheets)
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. ______.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: ______.

DETAILED ACTION

Response to Arguments

1. Applicant's arguments with respect to claims 1-48 have been considered but are moot in view of the new ground(s) of rejection.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 1-4, 9-11, 13-28, 33-35, 37-48 are rejected under 35 U.S.C. 103(a) as being unpatentable over US 6191399 B1 (Van Bilsen; Frank B. M., herein after VAN BILSEN) in view of US 5225245 A (Ohta; Tomohiro *et al.*, hereinafter OHTA) and

With respect to Claims 1 and 25: VAN BILSEN discloses or suggests, in a heated substrate processing system, which may be used for Chemical Vapor Deposition (CVD), a method and apparatus for determining the temperature of a substrate, comprising:

positioning said substrate 16 on a substrate support structure (18, Fig. 1), wherein said substrate support structure includes a chuck (considered to be the wafer holder 20, which is supported by spider 22 mounted to a shaft 24 which extends through a tube 26; Col. 4, Lines 32-37);

creating a temperature calibration curve (Col. 7, Lines 1-67) for said substrate, said temperature calibration curve (e.g., adding an offset to make the pyrometer 21 readings match the thermocouple 28 at the first temperature) being created by measuring at least a first substrate temperature with an electromagnetic measuring device (non-contact temperature sensor 21 such as a pyrometer), and measuring a first

wafer temperature with a physical measuring device (thermocouple 28) during a first isothermal state (a stable temperature portion, Tf, Fig. 4); and

employing a measurement from said electromagnetic measurement device and said temperature calibration curve to determine a temperature of said substrate during processing of said substrate.

Regarding Claims 2 and 26: VAN BILSEN further discloses selecting a setpoint and calibrating the pyrometer by measuring the temperature of the substrate using the thermocouple when the setpoint has been reached, and is stable, considered an "isothermal state" of the system, VAN BILSEN refers to as a "steady state portion of the recipe" (Col. 2, Lines 55-65; Col. 7, Lines 17-24).

VAN BILSEN further discloses the support structure further comprises said physical temperature measuring device, as claimed by Applicant in Claims 4 and 28, the physical temperature measuring device is a thermocouple device 28, as claimed by Applicant in Claims 9 and 33.

VAN BILSEN, as described above, does not disclose the method and apparatus being used in a plasma processing system as claimed by Applicant in Claims 1 and 25, wherein the chuck temperature is measured with the physical measuring device in thermal contact with said chuck during a first isothermal state of said substrate, in the absence of a plasma in said system and then determining the temperature during plasma processing (plasma being present) when employing the electromagnetic measurement device.

Moreover, VAN BILSEN, as described above, does not disclose the plasma processing system comprises ***plasma processing*** system(s) for chemical vapor deposition, plasma enhanced chemical vapor deposition, and/or physical vapor deposition as claimed by Applicant in Claims 13-15 and 37-39.

Moreover, VAN BILSEN, as described above, does not disclose the method and apparatus wherein said substrate is positioned between said plasma and said electromagnetic device as claimed by Applicant in Claims 3 and 27.

OHTA discloses, in a heated processing system, including a thermocouple 13, and "non-contact type thermometer 9, *e.g.,* a radiation pyrometer", which may be used for Chemical Vapor Deposition (CVD), that the system can be modified to use plasma (Col. 1, Lines 45-68). Moreover, the system can be used for plasma enhanced chemical vapor deposition and physical vapor deposition (Col. 7, Line 24 - Col. 8, Line 6) as claimed by Applicant in Claims 13-15 and 37-39.

OHTA further discloses that it is advantageous to substitute plasma for the filament, as the decomposing means for decomposing the source gas in order to benefit from the ability to make thin films of superior quality.

OHTA is evidence that ordinary workers in the field of thin film manufacturing processes would recognize the benefit of using plasma as taught by OHTA in a CVD reactor using the temperature calibration method of VAN BILSEN in order to benefit from the ability to make thin films of superior quality using plasma.

Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to substitute plasma for decomposing the source gas in the system of OHTA in order to make thin films of superior quality using plasma as taught by OHTA and to use the method of temperature calibration of VAN BILSEN in that system in order to more accurately determine the operating temperature for a CVD recipe as taught by VAN BILSEN.

Regarding the further limitations, VAN BILSEN does disclose a chuck, but only a spider. OHTA discloses a chuck is used to hold the wafer. It would have been obvious to place the physical measuring device in thermal contact with the chuck of OHTA in order to measure the temperature of the substrate being held in thermal contact with the

chuck in order to more accurately measure the substrate temperature, since the temperature of concern is primarily the temperature of the substrate.

VAN BILSEN describes measurements of temperature done in the absence of plasma, while OHTA describes measurements of temperature done in the presence of plasma.

VAN BILSEN and OHTA do not describe the method wherein measurements are done using the physical measuring device, or thermocouple, in the absence of plasma, but using said electromagnetic device, the radiation pyrometer, in the presence of plasma as claimed by Applicant in Claim 1. Regarding Claim 25, this functional limitation is already met by the device of VAN BILSEN and OHTA, as described above, since the system is capable of measuring the temperature using the thermocouple, whether or not there is a plasma in the chamber.

BERRIAN discloses that plasma can adversely affect thermocouples used in a plasma processing environment (See Col. 1, Line 58 - Col. 2, Line 1): "In addition, it is often necessary to measure the temperature of one or more of the electrodes, particularly the heated carrier, in order to effectively control the plasma CVD or plasma etch process. Further, the measurement of electrode temperature is desirable even when that electrode is at high RF potential. Such a measurement is needed, for example, to ensure that the chemical reactions within the reactor do not occur directly at the electrode's surface as a result of being too hot or too cold. Accordingly, there is the need to directly measure the surface of the heated carrier electrode structure with a temperature sensing device such as a thermocouple. However, one problem with doing so is that it is difficult to separate the RF potential from the low voltage produced by the thermocouple. Specifically, the AC, RF electrode can have voltages of several thousand volts; while the typical thermocouple generates a voltage signal in the milli-volt range. Moreover, the thermocouple amplifiers, which are needed to provide a measurable diagnostic signal, do not generally tolerate AC currents, particularly at radiofrequencies." BERRIAN is evidence that it is known in the art of temperature

measurement that inaccurate measurements can be caused by high RF potential in a plasma chamber.

Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to use the physical measuring device, or thermocouple for calibration of the electromagnetic device, the radiation pyrometer, in the absence of plasma in order to avoid inaccurate measurements that can be caused by the high RF potential as taught by BERRIAN.

VAN BILSEN further discloses the wafer/substrate may be a silicon wafer, as Claims 10 and 34 have been considered, as described in Paragraph 1, above, and may be used for other substrates, such as for deposition of optical thin films on glass (Col. 3, Lines 33-50). VAN BILSEN does not explicitly disclose using the method and system for processing wherein said substrate is a glass panel. Official Notice is taken with respect to the intended use in processing a glass panel, since it is well known in the art that glass panels are commonly coated by CVD in order to provide improved optical properties. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to substitute a glass panel for the substrate of VAN BILSEN in order to apply a coating to the panel providing beneficial optical properties as is well known in the art.

Official Notice is taken with respect to the intended use of the particular processing gases as claimed by Applicant in Claims 13-24 and 37-48, since it is well known in the art that these gases are commonly used for either carrier gases or deposition gases for sputtering, plasma etching as well as deposition processes and Sulfur, Fluorine and Carbon compounds are commonly used for reactive sputtering, which are commonly done in the same plasma processing system as suggested by the teachings of VAN BILSEN in view of OHTA. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to use any of these gases for the various well-known processes that are commonly done in plasma reactors, such as surface preparation by sputter cleaning, then applying a coating to the

substrate providing the desired properties needed for the manufacture of thin film devices as is well known in the art.

4. Claims 5-8, 12, 29-32 and 36 are rejected under 35 U.S.C. 103(a) as being unpatentable over VAN BILSEN in view OHTA and further in view of US 6062729 A (Ni; Tuqiang *et al.*, hereinafter NI).

BILSEN in view OHTA discloses or suggests all the limitations as claimed by Applicant in Claims 5-8, 12, 29-32 and 36, as described above in Paragraph 3 regarding Claims 1-4, 9-11, 13-28, 33-35, 37-48, including the limitations wherein the electromagnetic measuring device comprises a pyrometer, each generally disclosing a pyrometer for temperature measurement and a radiation pyrometer. Neither BILSEN nor OHTA explicitly disclose the set of electromagnetic frequencies comprising the infrared spectrum as claimed by Applicant in Claims 12 and 36, and neither explicitly disclose the pyrometer being a narrow-band pyrometer as claimed by Applicant in Claims 5 and 29, or comprising the particular spectral discrimination devices as claimed by Applicant in Claims 6-8 and 30-32.

NI discloses that is known in the art to provide a plasma processing system with an infrared responsive technique for measuring substrate temperature (Col. 3, Lines 1-49).

NI further teaches that it is advantageous to use a broadband source including infrared frequencies as claimed by Applicant in Claims 12 and 36, and spectrally sensitive photodiode 24 in order to benefit from ability to discriminate from light generated by the plasma emissions (Col. 5, Lines 4-32).

NI teaches use of optic filters FA and FB in combination with a pair of photodiodes 26, 28 as claimed by Applicant in Claims 5, 8, 29 and 32. Regarding claims 6-7 and 30-31, the monochrometer and grating are dispersive filters, art-recognized equivalents for band-pass optical filters as is well known in the art of temperature measurement.

NI is evidence that ordinary workers in the field of semiconductor processing device temperature measurements would recognize the benefit of providing a broadband source including infrared frequencies and spectrally sensitive detection as taught by NI for the pyrometers of BILSEN and OHTA in order to discriminate from the plasma generated light wavelengths, in order to more accurately measure the temperature of the substrate in the presence of the plasma.

Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to substitute the temperature measurement of NI for the pyrometer of BILSEN and OHTA in order to more accurately measure the temperature of the substrate in the presence of the plasma as taught by NI.

Allowable Subject Matter

5. Claim 49 is allowed.

6. The following is a statement of reasons for the indication of allowable subject matter: A closely related prior art patent is 6116779 A (Johnson; Shane R. et al., hereinafter JOHNSON).

JOHNSON discloses, in a plasma processing system (Col. 1, Lines 8-16), a method of determining the temperature of a substrate during plasma processing, comprising:

creating a mathematical model (Col. 8, Lines 1-54; Figs. 3-4; Col. 7, Lines 48-68, and following) relating temperature changes of said substrate to optical properties changes of said substrate (Col. 3, Lines 49-59), including

a) positioning said substrate (wafer 5) on a substrate support structure of said plasma processing system, wherein said substrate support structure includes a chuck (metal ring 8; Col. 5, Lines 10-16), "a thermocouple clipped to the substrate"; Col. 11, Lines 10-45), is considered to be thermally attached to the chuck, with the substrate and said chuck required to come to thermal equilibration, in order to provide accurate measurement of the wafer temperature by way of the chuck temperature, at which time said chuck temperature is measured using a contact measurement technique,

d) directing electromagnetic radiation of known spectral composition (a broadband lamp 1 with long pass filter 16; Col. 5, Lines 31-37; 45-53) onto a surface of said substrate 5,

e) obtaining first electromagnetic energy measurement, said first electromagnetic energy measurement measuring first electromagnetic energy reflected from said surface of said substrate responsive to said directing (Col. 6, Lines 55-68).

JOHNSON as described above, does not teach introducing a heat transfer gas between said substrate and said chuck, allowing said substrate and said chuck to come to thermal equilibration, at which time said chuck temperature is measured using a contact measurement technique; then employing said chuck temperature measured using said contact measurement technique and said first electromagnetic energy measurement to create said mathematical model.

In contrast, during the calibration step, JOHNSON uses a thermocouple in direct thermal contact. JOHNSON recognizes the problem of using a thermocouple close to the wafer without touching, depending only on radiative contact with the substrate for heat transfer, or equilibration (Col. 1, Lines 25-43), which may have errors of 100 degrees Celsius using that approach. He solves this by using the direct contact approach during the calibration step.

Thus, JOHNSON does not anticipate or fairly suggest the step of using the same substrate for both the calibration step and the measuring step during plasma processing, that is, calculating said temperature of said substrate during said plasma processing as claimed by Applicant, in combination with all the other limitations of Claim 49.

Conclusion

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. The prior art cited in a form PTO-892 and not mentioned above disclose related temperature measurement devices and methods.

Already cited prior art:

US 6106148 A (Moslehi; Mehrdad M. et al.), in a plasma processing system, calibrates a pyrometer using a thermocouple, wherein the thermocouple is touched to a wafer during a ramping of temperature of the wafer. There is no measuring a first chuck temperature with a physical measuring device during a first isothermal state. The ramp rate must be slow enough for the thermocouple probe to respond to correlate with the pyrometer response.

US 4854727 A (Pecot; Michel et al.), as described in VAN BILSEN, "discloses an exemplary method for calibrating the emissivity characteristics of a semiconductor wafer temperature measurement element. [Pecot et al.] discloses comparing the temperature measured within a susceptor in close proximity to the center of the wafer with the temperature measured by a radiation pyrometer by using a sample wafer, prior to the processing of a batch of similar wafers. The temperature measurements for the wafers in the batch are corrected with reference to the measurements taken by using the sample wafer." Pecot *et al.* does not disclose or fairly suggest employing a measurement from said electromagnetic measurement device and said temperature calibration curve to determine a temperature of said substrate during plasma processing.

US 6575622 B2 (Norrbakhsh; Hamid et al.) discloses an electromagnetic measuring device (optical or fluoroptical temperature sensor) including measurements of a test wafer and also physical contact device measuring a wafer support temperature, in order to establish a database for corrections made during temperature measurements during plasma processing. Also discloses use of Helium gas for conducting heat.

US 5823681 A (Cabib; Dario et al.), in a plasma processing system, calibrates an electromagnetic measuring device using a thermocouple 44 embedded in a chuck (heater 46), wherein the thermocouple is used to compensate for the background radiation caused by the heater. Also uses gas to equilibrate the temperature of the heater and the reference wafer.

The following disclose related temperature calibration and measuring methods:

- US 6283630 B1 (Yazawa; Minoru);
- US 20010014111 A1 (Shimizu, Masahiro).

The following disclose related apparatus:

- US 5021980 A (Poenisch; Paul et al.);
- US 4919542 A (Nulman; Jaim et al.).

<u>The newly cited prior</u> art also disclose related temperature measurement devices and methods. PALFENIER et al. and SCHIETINGER et al. disclose optical pyrometers in related environments. YAUW et al. discloses plasma etching devices including source gases, electrostatic chuck holding a substrate of silicon or glass, and a chuck pedestal with temperature probe. HASHIKURA et al. disclosed a thermocouple embedded in a susceptor in a plasma processing system. STEGER also disclosed embedded temperature sensors, and teaches use of heat transfer gas.

8. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Stanley J. Pruchnic, Jr., whose telephone number is **(571) 272-2248**. The examiner can normally be reached on weekdays (Monday through Friday) from 7:30 AM to 4:00 PM. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Diego F. F. Gutierrez can be reached at **(571) 272-2245**.

The ***Official FAX*** number for Technology Center 2800 is **(703) 872-9306** for ***all official communications***.

Any inquiry of a general nature or relating to the status of this application or proceeding may be directed to the official USPTO website at **http://www.uspto.gov/** or you may call the **USPTO Call Center** at **800-786-9199** or 703-308-4357. The Technology Center 2800 Customer Service FAX phone number is (703) 872-9317.

The cited U.S. patents and patent application publications are available for download via the Office's PAIR. As an alternate source, all U.S. patents and patent application publications are available on the USPTO web site (www.uspto.gov), from the Office of Public Records and from commercial sources.

Private PAIR provides external customers Internet-based access to patent application status and history information as well as the ability to view the scanned images of each customer's own application file folder(s).

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Stanley J. Pruchnic, Jr.
5/17/05

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